U.S. Department of Transportation
Federal Aviation Administration

Subject:	INFORMATION: Unusable Fuel Quantity for Gulfstream GV Airplane	Date:	
From:	Manager, Transport Airplane Directorate, ANM-100	Reply to Attn. of:	97-111-44
To:	Manager, Atlanta Aircraft Certification Office, ACE-115A		

This letter is in regard to establishing appropriate criteria to be used in determining the unusable fuel quantity for the Gulfstream GV airplane. This subject was brought to our attention by your Flight Test and Systems Branch, ACE-116A, as a result of the airplane attitude limits Gulfstream proposed to use in determining the unusable fuel quantity for the GV.

Gulfstream letters A&C-FAA-97-387 and -387A submitted the original Gulfstream position used in developing Issue Paper P-7, entitled "Unusable Fuel Supply Determination," to address the subject. Subsequent to development of the Issue Paper draft, Gulfstream revised their approach for determining unusable fuel, as submitted in their letter A&C-FAA-97-552. Gulfstream believes that the approach they propose to take is consistent with current industry practice, and therefore, an Issue Paper is not necessary.

We have reviewed Gulfstream's method of determining the unusable fuel quantity, as presented in report number GV-GER-1261, "Gulfstream V Unusable Fuel Analysis," dated July 14, 1997, and does not agree with Gulfstream's conclusions regarding the critical airplane attitudes and conditions to be considered for determining unusable fuel. We also disagree with Gulfstream's assertion that they employed industry-standard analysis methods.

The methods and criteria presented below represent standard practice as applied to recently certificated transport category airplanes and is the basis for determining the unusable fuel quantity for the GV:

a. The unusable fuel supply determination required by FAR 25.959 is the basis for setting the zero point for the fuel gauges. The rule requires the unusable fuel quantity for each tank to ". . .be established at not less than the quantity at which the first evidence of engine malfunction occurs under the most adverse fuel feed condition for all intended operations and flight maneuvers involving fuel feed from that tank." The airplane does not have to be capable of completing any flight maneuvers (e.g., go-around) with only the unusable fuel quantity remaining.

b. The unusable fuel supply analysis should determine the amount of unusable fuel as a function of airplane attitude (i.e. pitch and roll). The unusable fuel analysis should also consider sideslips and dynamic maneuvers such as go-around pitch-up and acceleration as prescribed by paragraph 112 of Order 8110.8, "Engineering Flight Test Guide for Transport Category Airplanes," and paragraph 109 of draft Advisory Circular (AC) 25-7-X, "Flight Test Guide for Certification of Transport Category Airplanes".

c. Airplane attitude limitations may be used as a means of reducing the unusable fuel quantity provided it is demonstrated that likely operational flight maneuvers can be accomplished with those

attitude limits. Nose down pitch attitude should not be less than that for normal descent, approach, and landing maneuvers. Nose up pitch attitude consistent with a normal go-around condition, or a minimum of 10° nose up, whichever is less, must be considered. Roll attitude limitations should not be less than that required to enter a normal traffic pattern, intercept the final approach course, and land. Steady state sideslips anticipated during operation with the airplane in both the approach and landing configurations; in accordance with the FAA Handling Qualities Rating Method (see Appendix 7 of Draft AC 25-7-X), normal atmospheric disturbance levels for these operations include 10 knot crosswinds with light turbulence.

d. If a fuel system component failure would result in a significant reduction in usable fuel, the unusable fuel supply test should include a determination of this quantity. The effects of the failure on the unusable fuel quantity should be presented in the Airplane Flight Manual (AFM). (Note: Failure case unusable fuel is considered information only and is not related to determining the zero reading of the fuel quantity gauges.)

e. The results of the unusable fuel quantity analysis addressed by Items b through d, above, must be validated by flight tests. Fuel flow to the engines must not be interrupted when the critical flight maneuver(s) are flown with the fuel quantity predicted by analysis in the test tank.

f. Additionally, flight tests must be conducted to confirm that at the fuel quantity at which the low fuel warning light/message illuminates, it is possible to complete a go-around, approach, and return to landing, without fuel feed interruption, using the normal go-around pitch attitude; this should include go-arounds accomplished with the aid of automated flight guidance systems.

g. If airplane attitude limitations are employed to reduce the unusable fuel quantity, as described in “c.” above, those attitude limitations must be published in AFM as limits for flight maneuvers after the low fuel warning light/message illuminates. This will provide insurance that the fuel remaining that is above the unusable quantity can be used without risk of fuel feed interruption to the engines. Flight tests must be conducted to confirm that the proposed pitch attitude limit:

(1) is practical in terms of airplane flight characteristics for accomplishing a go-around, and

(2) will not result in lift and drag characteristics that will increase the time and/or fuel quantity necessary to complete the go-around to a point where the fuel remaining is less than the unusable fuel quantity.

h. Assurance of flight crew awareness of any airplane attitude limitations and their resulting effect on flight maneuvers should be demonstrated. Consideration should be given to integrating any airplane attitude limits associated with unusable fuel quantity determination into automated flight guidance systems (e.g. flight director command bars). The low fuel warning light/message trigger point should be used to limit the automatic flight guidance systems.

Sincerely,

Ronald T. Wojnar
ANM-111